

## LESSON 2: CHEMICAL FORMS AND EXPOSURE HAZARDS

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## TRAINER'S NOTES: Introduction and Learning Objectives

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*Ask trainees to look at the Introduction and Learning Objectives on page 2-1 of their Student Workbook and emphasize the following:*

- We saw in Lesson 1 how the Standard helps protect people by communicating information about chemical hazards in the workplace.
- In this lesson, you'll see —
  - what forms chemical materials take;
  - how and where chemical materials get into the air;
  - how chemical materials can enter your body; and
  - what factors affect the degree of hazard or risk associated with exposure to health hazards.

# LESSON 2: CHEMICAL FORMS AND EXPOSURE HAZARDS

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## INTRODUCTION

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Many work processes require the use of hazardous chemicals. Having a safe and healthful work environment means that you must recognize potential chemical hazards and protect yourself from them. In this lesson you will see what forms chemicals take, and how chemicals can enter your body.

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## LEARNING OBJECTIVES

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When you have completed this lesson, you should be able to do the following

- Define physical hazards and health hazards.
- Identify the forms that chemicals take.
- Describe how liquids and solids become airborne.
- Identify sources of mists, vapors, dusts, and fumes in the workplace.
- List and describe the major routes of exposure for health hazards.
- Identify factors that affect the degree of hazard associated with exposure to health hazards.
- List the categories of chemicals not included in the Hazard Communication Standard.

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**TRAINER’S NOTES: Learning Resources**

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Videotape Segments 2A and 2B, located on Tape 1

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**TRAINER’S NOTES: Directions for Proceeding**

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*Direct trainees to disregard Student Workbook page 2-2 and to proceed to page 2-3 in the Workbook.*

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## LEARNING RESOURCES

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- Videotape Segment 2A: Chemical Forms
- Workbook Application Exercise 2A-1: Recognizing Chemical Hazards
- Workbook Application Exercise 2A-2: Identifying Sources of Airborne Hazards
- Videotape Segment 2B: Exposure Routes and Degree of Hazard
- Workbook Application Exercise 2B: Routes of Exposure
- Lesson Summary

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## DIRECTIONS FOR PROCEEDING

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*Complete the following steps in order. You might want to **check** off each step as you complete it.*

- 1) Read the workbook introduction to Videotape Segment 2A.
- 2) Watch Videotape Segment 2A.
- 3) Complete Application Exercise 2A-1 in this workbook.
- 4) Complete Application Exercise 2A-2 in this workbook.
- 5) Read the workbook introduction to Videotape Segment 2B.
- 6) Watch Videotape Segment 2B.
- 7) Complete Application Exercise 2B in this workbook.
- 8) Read the lesson summary.

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## TRAINER'S NOTES: Introduction to Videotape Segment 2A

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*Emphasize that the Standard covers the majority of chemical hazards in the workplace. Then refer trainees to page 2-3 of their Student Workbook and briefly mention categories of chemical hazards not covered by the Standard.*

- Hazardous wastes regulated by the Environmental Protection Agency (EPA)

*Example:* contaminated soils and waste solvents covered under EPA regulations.

- Tobacco and tobacco products

*Example:* cigarettes

- Wood and wood products

*Example:* lumber, paper

- Manufactured articles with a specific shape or design, and an end-use function dependent on that shape or design — provided that such articles do not release or cause exposure to a chemical hazard under normal conditions of use.

*Example:* chairs, phonograph records, styrofoam cups

- Food, drugs, and cosmetics intended for personal consumption by employees while in the workplace.

*Example:* candy bars, aspirin, lipstick

- As we watch this videotape, you should learn —

- to distinguish between physical hazards and health hazards,

- “ to identify solids, liquids, and gases; and

- to recognize how and where solids and liquids get into the air as mists, vapors, dusts, and fumes.

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## INTRODUCTION TO VIDEOTAPE SEGMENT 2A: Chemical Forms

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In Lesson 1, you saw that the Hazard Communication Standard helps protect your right to work in a safe and healthful environment. The Standard does this by requiring actions that contribute to the recognition, evaluation, and control of chemical hazards in the workplace. The Standard includes most chemical hazards, but not all. For example, the following are not covered:

- Hazardous wastes regulated by the Environmental Protection Agency (EPA)

*Example:* contaminated soils and waste solvents covered under EPA regulations

- Tobacco and tobacco products

*Example:* cigarettes

- Wood and wood products

*Example:* lumber, paper

- Manufactured articles with a specific shape or design, and an end-use function dependent on that shape or design — provided that such articles do not release or cause exposure to a chemical hazard under normal conditions of use.

*Example:* chairs, phonograph records, styrofoam cups

- Food, drugs, and cosmetics intended for personal consumption by employees while in the workplace.

*Example:* candy bars, aspirin, lipstick

As you watch this videotape segment, look for the many types of chemical hazards the Standard *DOES* cover.

Learn to distinguish between physical hazards and health hazards. Also notice the forms chemicals can take, and the ways that chemical hazards get into the air.

If you wish, you may take notes on the following pages as you watch the tape.

Now, watch Videotape Segment 2A,

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## TRAINERS NOTES: Application Exercise 2A-1

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Ask trainees to turn to page 2-5 of their Student Workbook. Either lead the class through Application **Exercise** 2A-1 as a group activity, **or provide** time for students to complete the **exercise** individually or in small groups. The answers and additional information **given below** appear on pages 2-6 and 2-8 of the Student Workbook.

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Answer	Additional Information
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1) B D	<i>HEALTH HAZARDS</i> can cause illness or injury when you are exposed to hazardous chemicals by breathing, swallowing, skin contact, or eye contact.
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Irritants can cause injury to whatever part of your body they contact — e.g., skin, eyes, lungs.

Repeated skin contact with igniting explosives **or** flammable liquids, such as gasoline, can cause skin irritation. Breathing the vapors slows down the central nervous system. Asphyxiants cause **suffocation** by displacing oxygen in the air.

2) A B C D	Chemicals that are <i>PHYSICAL HAZARDS</i> can cause explosions, fires, violent chemical reactions, or other hazardous situations.
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All compressed gases present a physical hazard because they contain stored energy which can turn the gas cylinder into a powerful rocket.

Some substances are water-reactive **and** create a hazardous chemical reaction when mixed with water (water-reactive).

Spontaneously combustible chemicals present a **fire** hazard.

Corrosives can cause a dangerous situation by eating through metals and other materials. They also present a *HEALTH* hazard because they can eat away body tissues, causing burns.

3) <b>Note:</b>	<i>You may wish to use the master in the back of this book (Appendix E, page E-2) to make an overhead of the label, or write the caution statement on the chalkboard.</i>
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A B	Many <b>chemicals</b> are both physical <b>and</b> health hazards. This label warns you of a physical hazard (flammability) by telling you not to use the <b>chemical</b> near <b>fire</b> or flame. It warns you of a health hazard by telling you that the chemical is harmful when it enters your body — i.e., when swallowed, inhaled, or absorbed through the skin.
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## APPLICATION EXERCISE 2A-1: Recognizing Chemical Hazards

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*Directions: Check or **circle your** answer(s) to each question, or write your answer in the blank **provided**. When you **complete** the **exercise**, fold over the right side of the page to **check** your answers. Then turn the page to get **more** information about each question. Remember, there may be **more** than one answer.*

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- 1) Which of the following terms **identify** a **HEALTH** hazard associated with exposure to hazardous chemicals?
  - A) Explosives
  - B) Irritants
  - C) Flammable gases
  - D) Gasoline or asphyxiants
  
- 2) Which of **the** following terms describe a **PHYSICAL** hazard of a hazardous chemical?
  - A) Compressed gas
  - B) Water-reactive
  - C) Spontaneously combustible
  - D) Corrosive
  
- 3) The caution label on a can of insect killer **reads**:

**DO NOT USE NEAR FIRE OR FLAME. HARMFUL IF SWALLOWED, INHALED, OR ABSORBED THROUGH SKIN.**

What type of hazard(s) does this chemical present?

- A) Health
- B) Physical

**Answer**

**Additional Information**

4) Chemical materials exist in one of three basic physical forms.

(L) Glue

(L) Solvent

(L) Water

(G) Air

(S) Scouring powder

(S) Plastic

- SOLIDS, such as plastic, hold their shape. Each small granular particle of scouring powder also holds its shape.
- LIQUIDS take the shape of their container. Glue, water, and solvents are liquids.
- GASES have no definite shape. They can be compressed, and they expand to fill containers. Air is an example of a gas that is everywhere.

5) ABC

Chemicals in *ALL* physical forms can become airborne. ANY airborne chemical can be inhaled.

- Solids become airborne as fumes or dusts.
- Liquids become airborne as mists or vapors
- Gases become airborne if not contained

**Note:** *Direct trainees either to proceed to Application Exercise 2A-2 when finished or to wait for further instructions. If time allows, ask the Optional Questions that begin on page 2-12 of this guide.*

4) Classify each substance as either a SOLID (S), a LIQUID (L), or a GAS (**G**).

\_\_\_\_\_ Glue

\_\_\_\_\_ Solvent

\_\_\_\_\_ Water

\_\_\_\_\_ Air

\_\_\_\_\_ Scouring powder

\_\_\_\_\_ Plastic

5) Which state of chemical can become airborne and inhaled in the workplace?

A) Solid

B) Liquid

C) Gas

\_\_\_\_\_

*Now go back to page 2-5, fold over the right side of the page, and check your answers. Look on the back of the question page for more information on each question. If you are taking this course as a self-study, continue to Application Exercise 2A-2, "Identifying Sources of Airborne Hazards." If you are taking this course in a classroom situation, wait for further instructions from your trainer when finished.*

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## TRAINER'S OPTIONAL QUESTIONS: Exercise 2A-1

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01) *List choices and ask:* Which type of chemical can expand to fill a room?

- A) Solid
- B) Liquid
- C) Gas

**Answer:** C

All gases expand to fill their container. The “container” can be a cylinder, a confined space, or an entire room.

02) What are the two airborne forms of liquids?

**Answer:** Mist, Vapor

Liquids can become airborne as mists and vapors.

03) What are the two airborne forms of solids?

**Answer:** Dust, Fume

Solids can become airborne as dusts or fumes.



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## TRAINER'S NOTES: Application Exercise 2A-2

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*Ask trainees to turn to page 2-9 of their Student Workbook and either lead the class through Application Exercise 2A-2 as a group activity, or provide time for students to complete the **exercise** individually or in small groups. The answers and additional information given below appear on page 2-10 of the Student Workbook.*

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Answer	Additional Information
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1) A D

All airborne hazards —

- spread out from their source; and
- enter the body through breathing.

Not all airborne hazards settle quickly. Larger mist droplets and solid particles tend to settle, whereas smaller, lighter ones often remain airborne.

Most airborne hazards are NOT easily seen or smelled. Many are invisible and have no odor. The amount of airborne chemical that is hazardous to your health when inhaled maybe too small for you to see or smell.

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*You may wish to list the following choices on the chalkboard before you ask questions 2,3, and 4.*

A) Dust B) Fume C) Vapor D) Mist E) Gas

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2) c

Vapors form above any exposed liquid surface.

When a container of liquid is opened or leaks, a vapor is formed. Most liquid transfer operations produce vapors.

3) A

Dust (tiny solid particles) becomes airborne during mechanical operations like grinding, crushing, pulverizing, and abrasive cleaning.

Transfer of granular, fibrous, *or* powdered solids such as cement mix or asbestos, also produces dust.

Solids become airborne as fumes as well, but mechanical operations don't produce fumes. Fumes form when solids are melted,

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**APPLICATION EXERCISE 2A-2:**  
**Identifying Sources of Airborne Hazards**

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*Directions: Check or circle your answer(s) to each question, or write your answer in the blank provided. When you complete the **exercise**, fold over the right side of the page to check your answers. Then turn the page to get more information about each question.*

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- 1) Which properties are common to all airborne hazards?
  - A) Spread out from the source
  - B) Settle quickly
  - c) Easily seen and smelled
  - D) Normally enter the body through breathing
  
- 2) What type of airborne hazard probably forms when a solvent such as gasoline is transferred from a drum to a can?
  - A) Dust
  - B) Fume
  - C) Vapor
  - D) Mist
  - E) Gas
  
- 3) What type of airborne hazard probably results from grinding clean, dry metal parts?
  - A) Dust
  - B) Fume
  - C) Vapor
  - D) Mist
  - E) Gas

<b>Answer</b>	<b>Additional Information</b>
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- |        |  |
|--------|--|
| 4) ABE | Smoke is a mixture of <b>fire</b> gases and tiny airborne dust or <b>fume</b> particles.<br>The <b>fire</b> which produced the smoke can also produce vapors and mists, although these are not part of the smoke itself. |
|--------|--|
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**Note:** *Direct trainees either to read the Introduction to Videotape Segment 2B when finished or to wait for further instructions. If time allows, ask the Optional questions that begin on page 2-18 of this guide.*



4) Which airborne hazard(s) is (are) present in smoke?

A) Dust

B) Fume

C) Vapor

D) Mist

E) Gas

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*Now **fold** over the right side of the page, and check your answers. Look on the **back** of the question page for **more** information on each question. If you are taking this course as a self-study, proceed to the Lesson **Summary** when you have finished. If you **are** taking this **course** in a classroom situation, wait for further instructions from your **trainer** when finished.*

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## TRAINER'S OPTIONAL QUESTIONS: Application Exercise 2A-2

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*List the following choices on the chalkboard and ask questions 01 and 02.*

- A) Dust                      B) Fume                      C) Vapor                      D) Mist                      E) Gas
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- 01) What type of airborne hazard probably forms when liquid chemicals are mixed in an open agitator?

**Answer:** C, D; Vapor, Mist

Vapors form above any exposed liquid surface. Liquids form mists (tiny airborne droplets) when sprayed, bubbled, or stirred (agitated). Mists are often formed in spraying operations.

Mists also form when liquid vapors condense. This happens when coolants or lubricants are applied to hot surfaces.

- 02) What type of airborne hazard probably forms when metal parts are welded together?

**Answer:** B; Fume

Fumes form when a solid is melted. Welding, soldering, casting, and brazing produce fumes. (Ozone and nitrous oxide are examples of gases created from arc welding.)

Vapors rise from the surface of the liquid melt in these processes. When the vapors cool, they solidify to form tiny airborne fume particles,

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*Use the master provided in back of this book (Appendix E, page E-3) to make an overhead of the chart on page 2-18, or draw this chart on the chalkboard. Describe the chart. Then ask questions 03 through 06, which are based on the chart.*

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*Tell trainees:* Look at this flow diagram for an autobody repair process. First, the damaged part is removed with a cutting torch. The surrounding area is then sanded to remove old paint and cleaned with a solvent that removes oil and road film. The new part is then welded in place with an acetylene torch and finally, the part is spray painted.

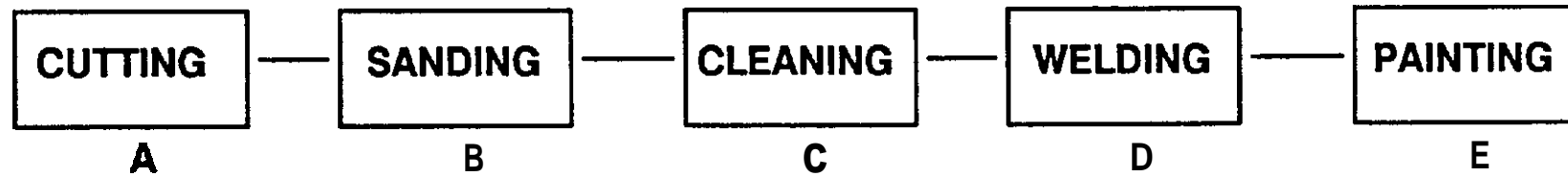
**STUDENT WORKBOOK: No Reference**

2-19

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**TRAINER'S OPTIONAL QUESTIONS: Application Exercise 2A-2 Continued**

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03) Which step or steps produce *DUST*?

**Answer:** B; Sanding

Paint *DUST* (tiny airborne particles) is formed during the sanding operation.

04) Which step or steps produce *FUMES*?

**Answer:** A, D; Cutting, Welding

*FUMES* are formed when a solid is melted — when the old part is cut off with a torch, and when the new part is welded in place.

05) Which step or steps produce *MISTS* or *VAPORS*?

**Answer:** C, E; Cleaning, Painting

A *MIST* or *VAPOR* is formed when liquids are applied and when liquids are removed in drying operations. The liquid cleaner produces vapor as it evaporates. Spray painting produces both mists and vapors.

06) Which step or steps produce *SMOKE*?

**Answer:** A; Cutting

Combustion produces *SMOKE*, which is a mixture of hot fire gases and tiny airborne dust or fume particles. Cutting produces smoke from combustion of the autobody paint. Welding produces smoke when parts are coated with paint or oil, but not when parts are clean.

**STUDENT WORKBOOK: No Reference**

**TRAINER’S OPTIONAL QUESTIONS: Application Exercise 2A-2 Continued**

07 )     Use the *master provided* in the back of this book (Appendix E, page **E-4**) to prepare **an** overhead of the following matrix and complete it as a group activity. You may also make a handout and invite **trainees** to complete the matrix **as** the discussion proceeds.

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*Tell trainees:* The table below lists various operations which produce airborne hazards. Across the top are the forms airborne hazards can take: Dust, smoke, **fume**, vapor, mist and gas. Let’s check off all the airborne hazards each process can produce. For example, welding can produce smoke, fume and gases.

For each *listed process*, ask: Which hazards can \_\_\_\_\_ produce?

	DUST	SMOKE	FUME	VAPOR	MIST	GAS
WELDING		x	x			x
SPRAY PAINTING						
GRINDING						
BRUSH PAINTING						
SANDING						
SWEEPING						
SOLDERING						
DECREASING						
DIPPING						

**Note:** After completing the matrix, ask trainees to *identify* operations or tasks in your facility that **are likely** sources of dust, **fumes**, mists, vapors, or gases.



**07)** *(Continued)*

**Answer:**

	DUST	SMOKE	FUME	VAPOR	MIST	GAS
WELDING		X	X			X
SPRAY PAINTING				X	X	
GRINDING	X					
BRUSH PAINTING				X		
SANDING	X					
SWEEPING	X					
SOLDERING		X	X			
DECREASING				X	X	
DIPPING				X		

*DUST* is made up of tiny airborne particles formed as solids are broken up or when granular or powdered solids are transferred as in grinding, sanding, sweeping.

*SMOKE* is a mixture of fire gases and airborne dust or fume particles. It is found in processes involving combustion or burning such as welding and soldering.

*FUME* particles are formed by cooling vapors from operations where solids have been melted as in welding and soldering.

*VAPORS* form above any exposed liquid surface as the liquid evaporates. Both spray painting and brush painting apply liquid paint to a surface. Decreasing and dipping operations also involve exposed liquid surfaces,

*MISTS* are formed as liquids are agitated or sprayed under pressure, such as in spray painting.

*GASES* may be compressed for use in a particular operation such as welding or they may be a by-product of the process itself, as in starting engines.





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## TRAINER'S NOTES: Introduction to Videotape Segment 2B

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**Note:** Ask *trainees* to look at the videotape introduction on page 2-13 of the Student Workbook and emphasize the following.

**You've** seen the forms chemicals can take. Now, let's see how these forms can enter your body.

■ As we watch this videotape, **you** should learn —

- to recognize the four exposure routes (inhalation, skin or eye contact, skin absorption, and ingestion); **and**
- to **identify** factors that affect the degree of hazard, or risk, associated with exposure to a health **hazard**.

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## INTRODUCTION TO VIDEOTAPE SEGMENT 2B: Routes of Exposure

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Exposure routes are ways that chemicals enter the body. This videotape segment describes four routes of exposure.

- Breathing/Inhalation
- Skin and eye contact
- Skin absorption
- Swallowing/Ingestion

Also look for the factors that **affect** degree of hazard when you are exposed by one of these routes.

If you wish, you may take notes on the following page as you watch the tape. Now, watch Videotape Segment 2B.

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## TRAINERS NOTES:Application Exercise 2B

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Ask trainees to turn to page 2-15 of their Student Workbook and either *lead the class* through Application **Exercise 2B** as a group activity, *or provide* time for students to complete the exercise individually or in small groups. The answers and additional information **given** below appear on page 2-16 of the Student Workbook.

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Answer	Additional Information
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- |            |  |
|------------|--|
| 1) ABC (D) | <p>Ingested <b>chemicals</b> can enter the bloodstream from the intestines. Many inhaled chemicals can pass from the lungs into the bloodstream. Some chemicals enter the bloodstream by being absorbed through skin. Skin absorption cannot occur without skin contact, but skin absorption does not always follow skin contact.</p> <p>Once in the bloodstream, chemicals can <b>affect</b> any part of your body.</p> |
| 2) Note    | <p>As a group <b>exercise</b>, you may wish to list choices A-D on the chalkboard and ask, "Which exposure route is most likely to cause _____? " for each given symptom.</p>  |
| D          | <p><b>RED, IRRITATED SKIN.</b> Skin contact hazards can cause anything from mild irritation and redness to severe burns.</p>   |
| ABC        | <p><b>DIFFICULTY IN BREATHING.</b> Inhalation hazards <b>can</b> affect the respiratory system on contact, making it hard to breathe. Chemicals that enter the bloodstream through skin absorption or ingestion can also affect the respiratory system.</p>  |
| B          | <p><b>BURNED ESOPHAGUS.</b> Chemicals that are ingested travel from the mouth, down the esophagus, and into the stomach, Damage can occur anywhere along this route.</p>   |
| ABC        | <p><b>HEADACHE, DIZZINESS.</b> Headache and dizziness occur when some chemicals enter the bloodstream — whether by inhalation, ingestion, or skin absorption.</p>  |

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## APPLICATION EXERCISE 2B: Understanding How Chemicals Enter Your Body

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*Directions: Check or circle your answer(s) to each question, or write your answer in the blank provided. When you complete the exercise, fold over the right side of the page to check your answers. Then turn the page to get more information about each question.*

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1) How can chemicals in the workplace enter your bloodstream?

- A) Ingestion
- B) Inhalation
- C) Skin absorption
- D) Skin contact

2) Match the exposure route(s) to the effect most likely to appear immediately.

\_\_\_\_\_ Red, irritated skin

\_\_\_\_\_ Difficulty in breathing

\_\_\_\_\_ Burned esophagus

\_\_\_\_\_ Headache, dizziness

A) Inhalation

B) Ingestion

C) Skin absorption

D) Skin contact

**Answer      Additional Information**

**3) Harry**      The degree of hazard greatly depends on dosage —

- how **MUCH** you are **exposed** to each time;
- . how **LONG** each exposure lasts; and
- how **OFTEN** you are exposed.

Harry’s dosage is higher because he is exposed eight hours a day, five days a week. Joe does not weld all day every workday.

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**Note:**    *Direct trainees either to proceed to the Lesson Summary when finished or to wait for **further** instructions. If time allows, ask the Optional Questions that begin on page 2-32 of this guide.*

- 3) Joe** welds occasionally as part of his job in a repair shop. **Harry** does the same kind of welding all day as part of his job. Is the degree of hazard higher for Joe or for Harry?
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*Now fold over **the right** side of the page, and check your answers. Look on **the back** of the question page for more information on each question. **If you** are taking this course as a self-study, proceed to the Lesson Summary when you have finished. **If** you are taking this course in a classroom situation, wait for further instructions **from** your trainer.*

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## TRAINER'S OPTIONAL QUESTIONS: Application Exercise 2B

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*Use the master provided in back of this book (Appendix E, page E-5) to make an overhead or handout of the sketches for questions 01 through 03.*

*Ask trainees to identify the name of the potential exposure route(s) (ingestion, skin contact, skin absorption, inhalation) for each worker.*

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01) Point to the sketch below and ask: How could this worker be exposed?



**Answer: Inhalation**

Airborne hazards **enter** the body through the nose or mouth when workers breathe. This is the most common exposure route, and often the most hazardous.

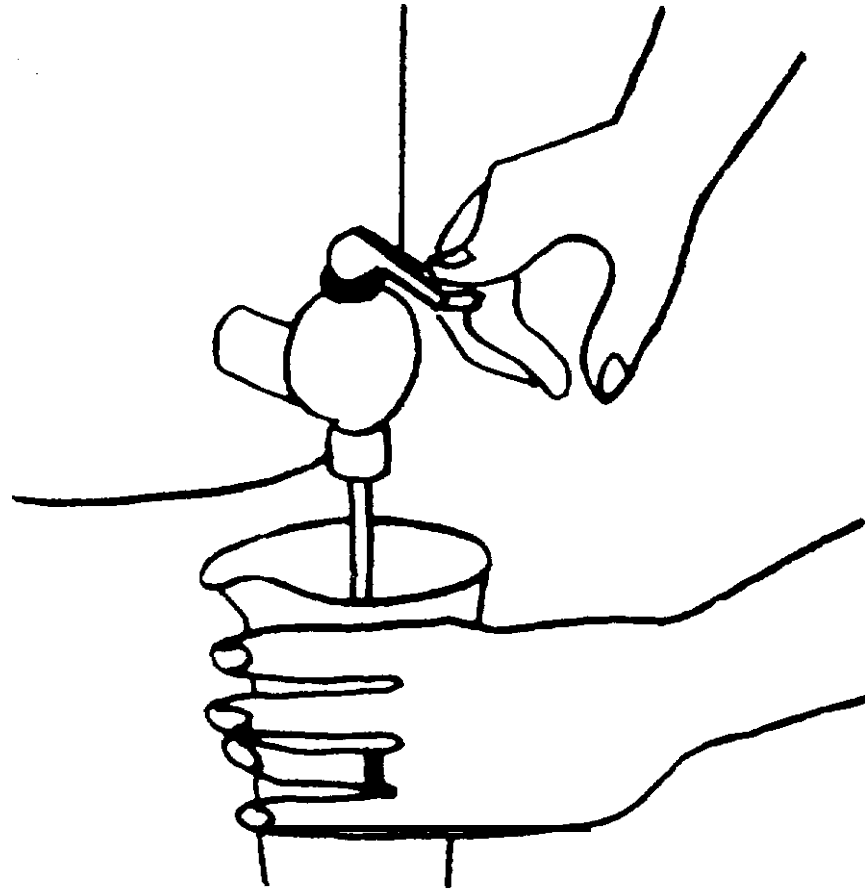
Inhaled chemicals travel from the mouth or nose, down the windpipe, and into the lungs. From the lungs, many chemicals enter the bloodstream.

Skin contact, skin absorption, and eye contact are not likely here because the working is wearing long gloves and goggles.





**02)** *Point to the sketch below and ask: How could this worker be exposed?*



**Answer:** Skin contact/absorption

Getting chemicals on the hands, or any other part of the body, can damage the skin on contact. Repeated exposure to some skin contact, hazards can also cause dermatitis.

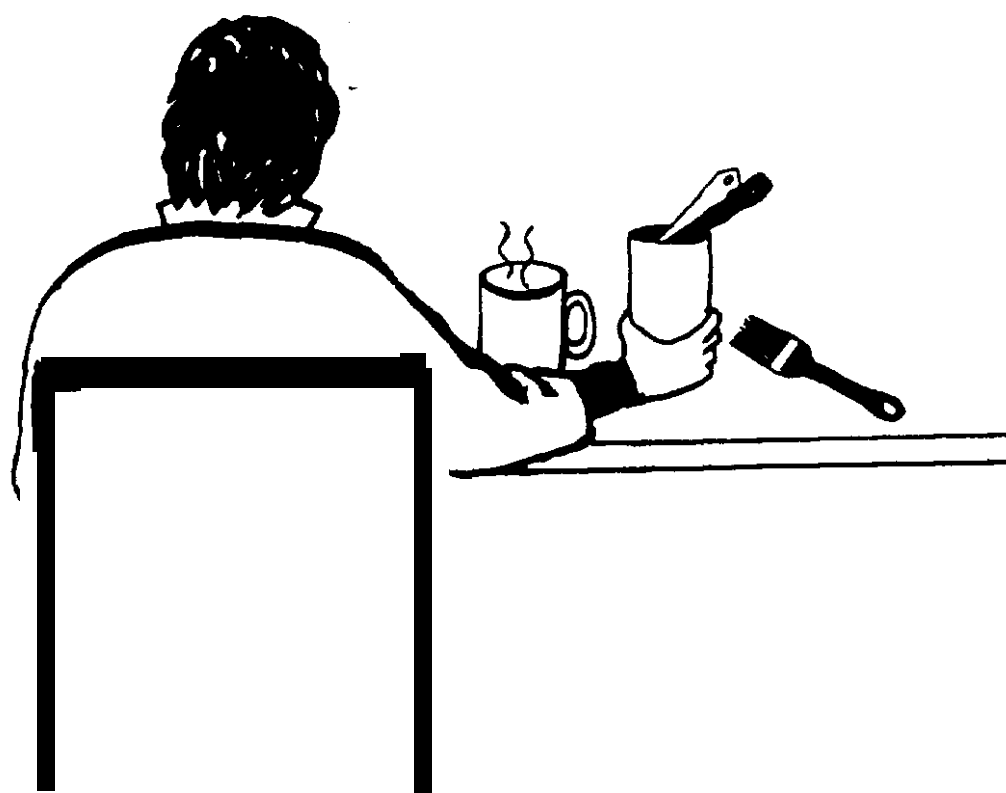
Skin absorption hazards pass through the skin on contact and enter the bloodstream.

A cut increases the risk of skin absorption. Chemicals that cannot enter the body through healthy skin can pass right through broken or damaged skin.

**STUDENT WORKBOOK: No Reference**

2-35

**03)** *Point to the sketch below and ask: How could this worker be exposed?*



**Answer:** Ingestion

**Chemicals** that are swallowed travel from the mouth, down the esophagus, and into the stomach. From the stomach chemicals can enter the intestines and be absorbed into the bloodstream.

Practicing good personal hygiene, keeping food and drink out of work areas where chemical hazards exist, and being especially careful to label chemical containers can help prevent exposure by ingestion.

**Although not likely, skin contact and absorption are possible, if the chemical is spilled. Likewise, inhalation of vapors is possible.**

Because the absorptive area of the lungs is so large, the body is very vulnerable to damage through inhalation.

**STUDENT WORKBOOK: No Reference**

**04)** *Tell trainees:* The internal surface area of the lungs is 750 to 1100 square feet.

*Ask trainees:* Which of the following is about 750 to 110 square feet in area?

- A) Top of a snack tray
- B) Top of a ping pong table
- C) Half a tennis court

**Answer:** C

The inside surface area of the lungs is 750 to 1100 square feet, about half the size of a tennis court! The total internal surface of the digestive tract is about 100 to 110 square feet. The skin totals about 20 to 22 square feet.

**05)** *Tell trainees:* MEK (methyl ethyl ketone) dissolves paint and varnish. It is also a skin absorption hazard. Joe uses MEK to clean paint off his hands.

*Ask trainees:* Can the paint enter Joe's body?

**Answer:** Yes

Using solvents to clean hands or skin can carry other chemicals into the bloodstream.

Like MEK, many solvents are skin absorption hazards. Chemicals that would not normally pass through the skin can do so when dissolved in such solvents.



06) *Tell trainees:* John and Bill work side by side performing the same job in a painting and coating operation. One day, for no apparent reason, John starts gasping for air. Bill remains fine.

*List choices and ask trainees:* Which of the following could explain what happened?

- A) John swallowed a toxic chemical.
- B) John inhaled paint vapor or mist,
- C) John developed a sensitivity to one of the chemicals in the paint.
- D) John started taking a new medication.

**Answer: A, C, D**

John may have accidentally swallowed some of a chemical. This would expose John, but not Bill.

It's also possible that John developed a sensitivity to one of the chemicals in the paint. This can happen any time after the first exposure to some chemicals. It can cause an allergic-like response such as a skin rash or trouble breathing.

Taking a new medication could also explain John's reaction. Exposure to two chemicals at the same time is often more serious than exposure to either chemical alone.

John could have been exposed by inhaling paint vapor or mist, but Bill would also have been exposed and, most likely, would also have reacted.



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*If time permits, review and reinforce learning objectives by asking the following open-ended questions answered in the Summary. After each question ask for specific examples from the trainees' work environment. Draw attention to the Summary for future reference.*

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**Q1)** What is a physical hazard?

**Answer:** *PHYSICAL HAZARDS* are chemicals that cause explosion, fires, violent chemical reactions, or other hazardous situations.

**Q2)** What is a health hazard?

**Answer:** *HEALTH HAZARDS* are chemicals that can cause illness or injury when inhaled or swallowed, or through contact with the skin or eyes.

**Q3)** What properties distinguish solids, liquids, and gases?

**Answer:** *SOLIDS* have a definite shape and can become airborne as dust or fume particles.

*LIQUIDS* take the shape of their container and can become airborne as mists or vapors.

*GASES* are easily compressed, expand to fill a container, and become airborne when not contained.

**Q4)** What are the airborne forms of a solid? How do solids become airborne?

**Answer:** Both *DUSTS* and *FUMES* are made up of tiny solid particles. Mechanical operations like grinding and crushing produce dust, So does transfer of powdered or fibrous solids and abrasive cleaning. Fumes form by vapor condensation when solids are melted in operations like welding and metal casting,

**Q5)** What are the airborne forms of a liquid? How do liquids become airborne?

**Answer:** *VAPORS'* are formed above any exposed liquid surface. Heating a liquid makes it vaporize more quickly. *MIST* is made up of tiny droplets that become airborne when liquids are sprayed, agitated, or applied to a hot surface. Mists also form when hot vapors cool in air and condense.

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## LESSON 2 SUMMARY

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The Hazard Communication Standard defines two main categories of chemical hazards

- *PHYSICAL HAZARDS* are chemicals that cause explosion, fires, violent chemical reactions, or other hazardous situations.
- *HEALTH HAZARDS* are chemicals that can cause illness or injury when inhaled or swallowed, or through contact with the skin or eyes,

All chemicals exist in one of three basic forms:

- *SOLIDS* have a definite shape and can become airborne as dust or fume particles.
- *LIQUIDS* take the shape of their container and can become airborne as mists or vapors.
- *GASES* are easily compressed, expand to fill a container, and become airborne when not contained.

Both *DUSTS* and *FUMES* are made up of tiny solid particles. Mechanical operations like grinding and crushing produce dust. So does transfer of powdered or fibrous solids and abrasive cleaning. Fumes form by vapor condensation when solids are melted in operations like welding and metal casting.

*VAPORS* are formed above any exposed liquid surface. Heating a liquid makes it vaporize more quickly. *MIST* is made up of tiny droplets that become airborne when liquids are sprayed, agitated, or applied to a hot surface. Mists also form when hot vapors cool in air and condense.

**Q1)** What are the four exposure routes?

**Answer:** The four exposure routes are breathing/inhalation, skin/eye contact, skin absorption, and swallowing/ingestion.

**Q2)** What happens when you inhale a health hazard?

**Answer:** *BREATHING/INHALATION* takes a chemical from the nose or mouth, down the windpipe, and into the lungs. Some chemicals get trapped in the lungs. Others leave the lungs when one breathes out or exhales, but many pass from the lungs into the bloodstream.

**Q3)** What can happen when skin or eye contact occurs?

**Answer:** *SKIN/EYE CONTACT* can cause anything from reddening or itching to severe rashes, burns, loss of eyesight or even death.

**Q4)** What is the difference between skin contact and skin absorption?

**Answer:** *SKIN ABSORPTION* hazards pass through the skin on contact and enter the bloodstream. Once in the bloodstream, chemicals can spread throughout the body and cause injury or disease far away from the original site of contact. Chemicals can also be absorbed through the mucous membranes of the eye.

**Q5)** What happens when you swallow a chemical?

**Answer:** *SWALLOWING/INGESTION* takes a chemical from the mouth, down the esophagus, and into the stomach. From the stomach many chemicals enter the intestines, where they can be absorbed into the bloodstream and spread throughout the body. Damage can be done at any point along the way.

Exposure routes are ways that chemicals enter your body. There are four main routes of exposure:

- ***BREATHING/INHALATION*** takes a chemical from your nose *or* mouth, down your windpipe, and into your lungs. Some chemicals get trapped in your lungs. Others leave when you breathe out. But many pass from your lungs into your bloodstream.
- ***SKIN/EYE CONTACT*** can cause anything from reddening or itching to severe rashes, burns, loss of eyesight or even death.
- ***SKIN ABSORPTION*** hazards pass through the skin on contact and enter the bloodstream. Once in your bloodstream, chemicals can spread throughout your body and cause injury or disease far away from the original site of contact. Chemicals can also be absorbed through the mucous membranes of the eye.
- ***SWALLOWING/INGESTION*** takes a chemical from your mouth, down your esophagus, and into your stomach. From your stomach, many chemicals enter the intestines, where they can be absorbed into the bloodstream and spread throughout your body. Damage can be done at any point along the way.

**Q6 )** What factors can affect the degree of hazard associated with exposure to a health hazard?

**Answer:** The *DEGREE OF HAZARD* associated with exposure to health hazards depends on the following.

■ *TOXICITY* of the chemical

Toxicity	Effects of Exposure
Low	Minor symptoms that go away when exposure stops
Medium	Require medical attention, may be permanent
High	Can cause death or severely disabling conditions

■ *EXPOSURE ROUTE*

Some chemicals are more toxic by one exposure route than by another. For example, onion juice vapor irritates the eyes, but skin contact with onion juice produces little or no effect.

■ *DOSAGE*, which depends on —

- . How MUCH chemical each exposure involves;
- How LONG each exposure lasts; and
- How OFTEN exposure occurs.

■ *INDIVIDUAL DIFFERENCES*, such as the following

- Work practices
- Age and size
- General physical and emotional health
- Allergies and sensitivities
- Level of exertion
- Combination of chemicals in the body, which depends on what medications a worker is taking and whether or not the worker smokes tobacco or drinks alcoholic beverages.

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• *EXPOSURE ROUTE*

Some chemicals are more toxic by one exposure route than by another. For example, onion juice vapor irritates the eyes, but skin contact with onion juice produces little or no effect.

• *DOSAGE*, which depends on —

- How *MUCH* you are exposed to each time;
- How *LONG* each exposure lasts; and
- How *OFTEN* you are exposed.

• *INDIVIDUAL DIFFERENCES*, such as the following

- Work practices
- Age and size
- General physical and emotional health
- Allergies and sensitivities
- Level of exertion
- Combination of chemicals in the body, which depends on what medications you are taking and whether or not you smoke tobacco or drink alcoholic beverages.